

Effect of socioeconomic status of neighborhoods in mortality mortality rates after brain injury: retrospective cohort

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Document version

Version	Alterations
01	Initial version

1 ABBREVIATIONS

- FIM: Functional Independence Measure
- HR: hazards ratio
- SD: standard deviation
- SES: socioeconomic status

2 CONTEXT

2.1 Objectives

To determine the effect of socioeconomic status of the neighborhood on mortality of patients with brain injury.

3 METHODS

The data procedures, design and analysis methods used in this report are fully described in the annex document **SAP-2023-004-BH-v01**.

This analysis was performed using statistical software R version 4.2.1.

4 RESULTS

4.1 Study population and follow up

There initially were 76665 observations on 19303 study participants considered for inclusion. After applying the inclusion and exclusion criteria for the study period between 2010-01-01 and 2018-12-31 and considering the status at the last available follow up time for each individual a total of 7972 participants were included in the analysis.

The epidemiological profile of the participant included in the study was a male participant (5,833 (73%)) with an average (SD) age of 31 (20) years. The average (SD) time of follow up was 5.24 (2.87) years.

Races were not homogeneously available in the study population with 5,251 (66%) individuals being white; 3,456 (43%) were single (never married) at the time of injury, and most participants were well educated with 3,573 (45%) at greater than high school level. A total of 4,709 (59%) were employed and 3,751 (48%) participants lived in an urban area.

Table 1 Epidemiological, demographic and clinical characteristics of study participants.

Characteristic	N = 7,972
SES quintiles, n (%)	
Prosperous	1,427 (22%)
Comfortable	1,338 (20%)
Mid-Tier	1,236 (19%)
At-Risk	1,296 (20%)
Distressed	1,289 (20%)
Unknown	1,386
Mortality, n (%)	1,198 (15%)
Time of follow up (years), Mean (SD)	5.24 (2.87)
Unknown	1,838
Sex, n (%)	
Male	5,833 (73%)
Female	2,132 (27%)
Unknown	7
What is your race?, n (%)	
White	5,251 (66%)

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Black	1,240 (16%)
Hispanic	1,071 (13%)
Other	398 (5.0%)
Unknown	12
What is your marital status?, n (%)	
Single (Never Married)	3,456 (43%)
Married	2,747 (35%)
Divorced	986 (12%)
Separated	263 (3.3%)
Widowed	482 (6.1%)
Other	17 (0.2%)
Unknown	21
Age at injury, Mean (SD)	
Unknown	31 (20)
Substance Problem Use, n (%)	
Unknown	2,919 (38%)
Education, n (%)	
Greater Than High School	3,573 (45%)
Less Than High School	1,522 (19%)
High School/GED	2,815 (36%)
Unknown	62
At time of injury, what was your employment status?, n (%)	
Employed	4,709 (59%)
Unemployed	871 (11%)
Other	2,350 (30%)
Unknown	42
Urbanization based on zip code of address at discharge., n (%)	
Suburban	2,336 (30%)
Rural	1,742 (22%)
Urban	3,751 (48%)
Unknown	143
Prior to this injury, has a physician ever told you that you have a seizure disorder?, n (%)	
Unknown	59 (5.7%)
Spinal cord injury:, n (%)	
Unknown	6,928
Spinal cord injury:, n (%)	
Unknown	456 (5.7%)
Spinal cord injury:, n (%)	
Unknown	22

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Cause of injury:, n (%)	
Vehicular	3,592 (45%)
Violence	709 (8.9%)
Falls	2,710 (34%)
Other	936 (12%)
Unknown	25
Primary rehabilitation payer:, n (%)	
Private Insurance	4,106 (52%)
Public Insurance	3,147 (40%)
Other	690 (8.7%)
Unknown	29
Residence after rehab discharge:, n (%)	
Private Residence	6,298 (79%)
Other	1,647 (21%)
Unknown	27
Days From Injury to Rehab Discharge, Mean (SD)	43 (34)
FIM Motor at Discharge:, Mean (SD)	52 (18)
FIM Cognitive at Discharge:, Mean (SD)	19 (7)

The observed overall mortality was 15% in the study period. The distribution of cases appear homogeneous across SES quintiles (Figure 1), ranging from 19% to 22%. We will test the effect of SES quintiles on the hazard rate in the next section. See also Figure A2 in the appendix for the distribution of sexes in each SES quintile in the study population.

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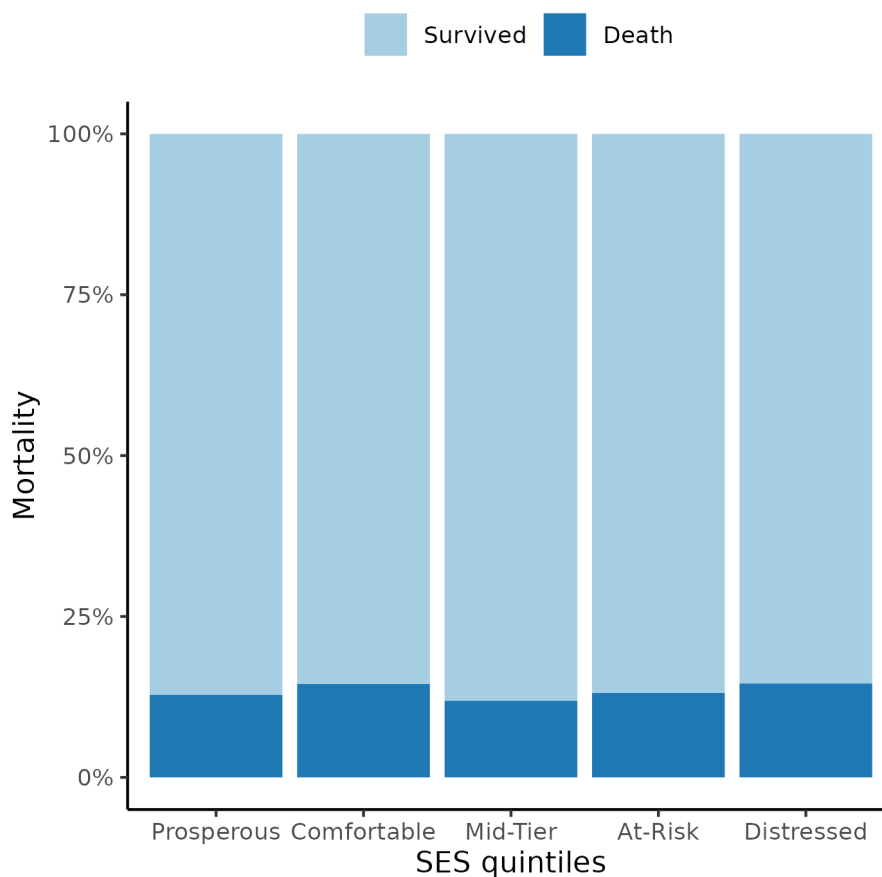


Figure 1 Proportion of cases per SES quintiles.

4.2 Effect of SES on mortality

The previous seizure disorder diagnosis was missing for most of the study population and was not included in the model as a covariate to preserve study power. After excluding participants with missing data from other variables a total of 4829 complete cases were available for analysis.

The survival curves of both sexes by SES quintiles can be seen in Figure 2. Since none of the curves cross, the proportional hazards assumption is assumed to be held in the study data. Overall, the distressed neighborhoods appear to have a lower survival probability than other neighborhoods. This appears to be true for both sexes, and males had a higher risk of dying than females in all neighborhoods. This plot was cropped at 85% survival for presentation purposes, see Figure A3 in the appendix for an uncropped version.

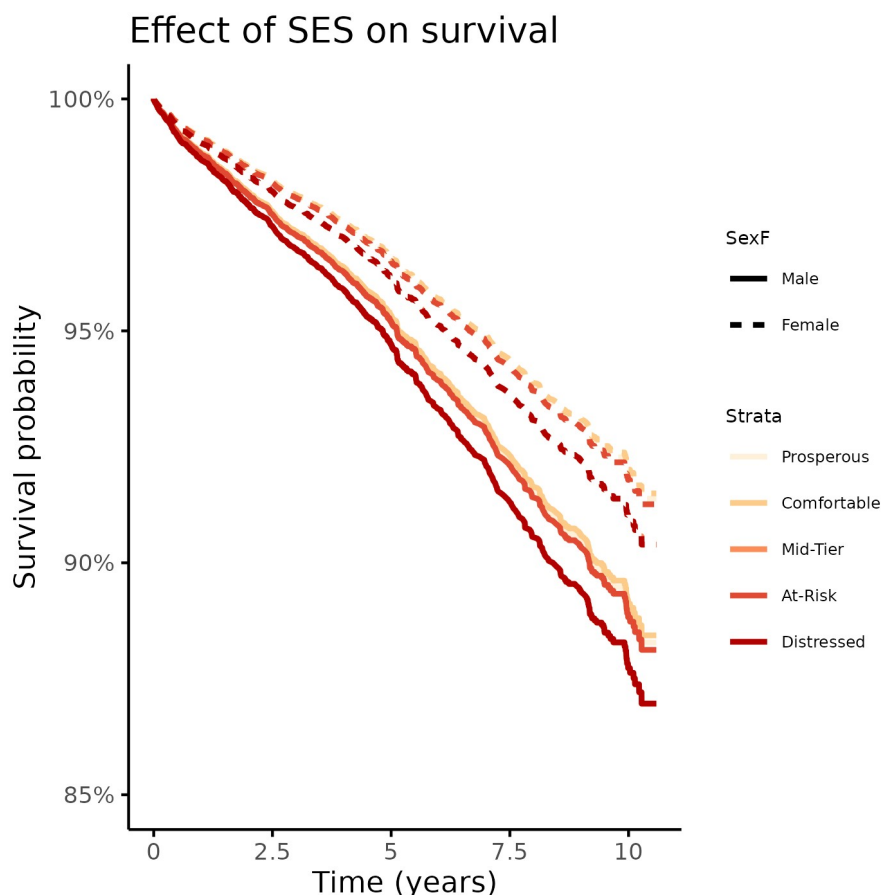


Figure 2 Survival of participants, by sex and by SES quintiles.

When considering only the crude effect of SES on mortality neighborhood to which the individuals were discharged was associated with mortality (Table 2). Participants who were discharged to a comfortable neighborhood had increased chance of dying (HR = 1.28, 95% CI = 1.04 to 1.57), when compared to those discharged to a prosperous neighborhood. Participants discharged to a distressed neighborhood also had a higher mortality risk (HR = 1.26, 95% CI = 1.02 to 1.55), when compared to those discharged to a prosperous neighborhood.

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Table 2 Effect of SES on mortality; HR estimates were adjusted for sex, race, age, substance abuse, education, employment status, urbanization, spinal cord injury, cause of injury, rehabilitation payer, residence after rehab discharge, days from injury to discharge, FIM motor and FIM cognitive at discharge.

Characteristic	Crude estimate			Adjusted estimate			Late deaths		
	HR [†]	95% CI [†]	p-value	HR [†]	95% CI [†]	p-value	HR [†]	95% CI [†]	p-value
SES quintiles									
Prosperous	—	—		—	—		—	—	
Comfortable	1.28	1.04 to 1.57	0.020	0.99	0.80 to 1.22	0.898	1.00	0.78 to 1.29	0.973
Mid-Tier	1.08	0.86 to 1.34	0.514	1.12	0.89 to 1.41	0.330	1.07	0.82 to 1.40	0.624
At-Risk	1.20	0.97 to 1.49	0.088	1.01	0.81 to 1.27	0.901	1.10	0.85 to 1.42	0.483
Distressed	1.26	1.02 to 1.55	0.029	1.12	0.89 to 1.41	0.333	1.06	0.81 to 1.38	0.684

[†]HR = Hazard Ratio, CI = Confidence Interval

After controlling for all relevant covariates, this effect can no longer be consistently detected, at the 5% level of significance. The point estimates for all adjusted estimates of SES effect range from 0.99 to 1.12, relative to the prosperous neighborhood, and that represents a narrower range of point estimates than the crude estimates (from 1.08 to 1.28).

When considering only late deaths the SES effect is also not significantly associated with mortality, and estimates relative to a prosperous neighborhood range from 1.00 to 1.07 (which is an even narrower range than the crude estimates). The adjusted estimates of all-time mortality can be compared with late mortality where in all neighborhoods the CI of the adjusted estimate is contained within the late death CI's, except for mid-tier and distressed neighborhoods that exceed the respective upper ranges of confidence by a diminute margin (presumably due to precision and study power). The respective point estimates in all cases do not change by a large amount, where most differences fall under 0.1 HR. It can be concluded that effect of SES on the risk of late death is not substantially different from all-time death in the study population, after controlling for all covariates.

5 OBSERVATIONS AND LIMITATIONS

Recommended reporting guideline

The adoption of the EQUATOR network (<http://www.equator-network.org/>) reporting guidelines have seen increasing adoption by scientific journals. All observational studies are recommended to be reported following the STROBE guideline (von Elm et al, 2014).

6 CONCLUSIONS

The epidemiological profile of the study participant is an 31 years old white male, that has greater than high school level of education, is actively employed and lives in an urban setting.

There appears to be a crude effect of SES on mortality, where participants that were discharged to either a comfortable or a distressed neighborhood had increased risk of death when compared to those discharged to a prosperous neighborhood. After controlling for other variables there is no association between SES and mortality.

Both early deaths and late deaths appear to occur at similar rates across all neighborhoods.

7 REFERENCES

- **SAP-2023-004-BH-v01** – Analytical Plan for Effect of socioeconomic status of neighborhoods in mortality mortality rates after brain injury: retrospective cohort
- von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg. 2014 Dec;12(12):1495-9 (<https://doi.org/10.1016/j.ijsu.2014.07.013>).

8 APPENDIX

8.1 Exploratory data analysis

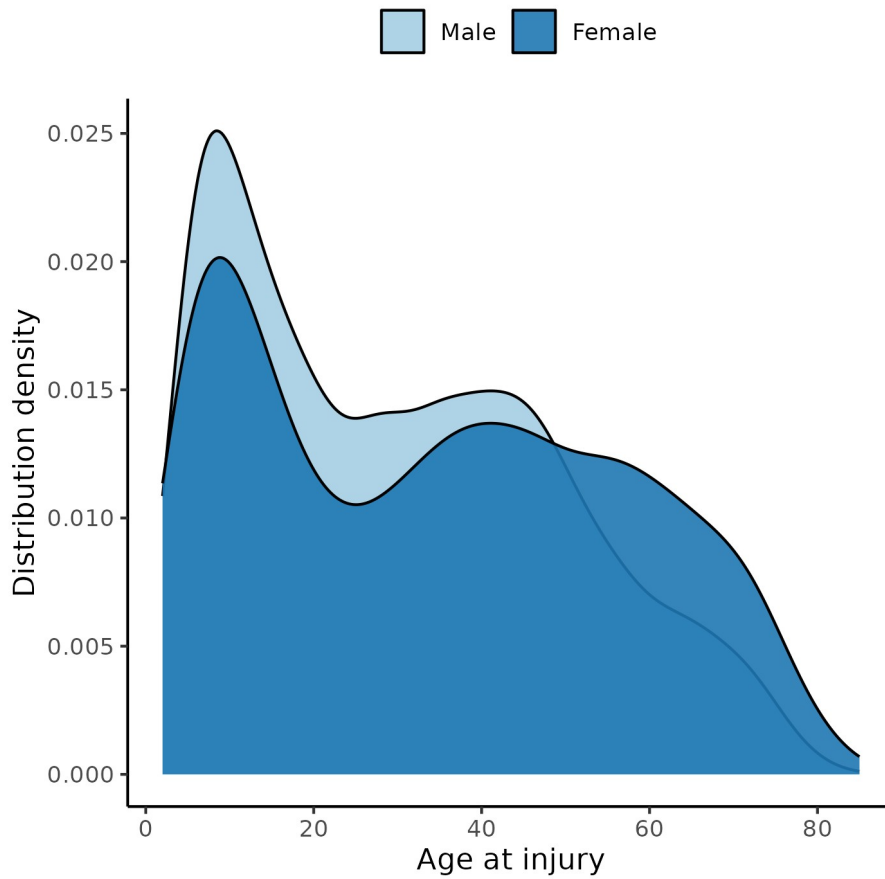


Figure A1 Distribution of age in the study population.

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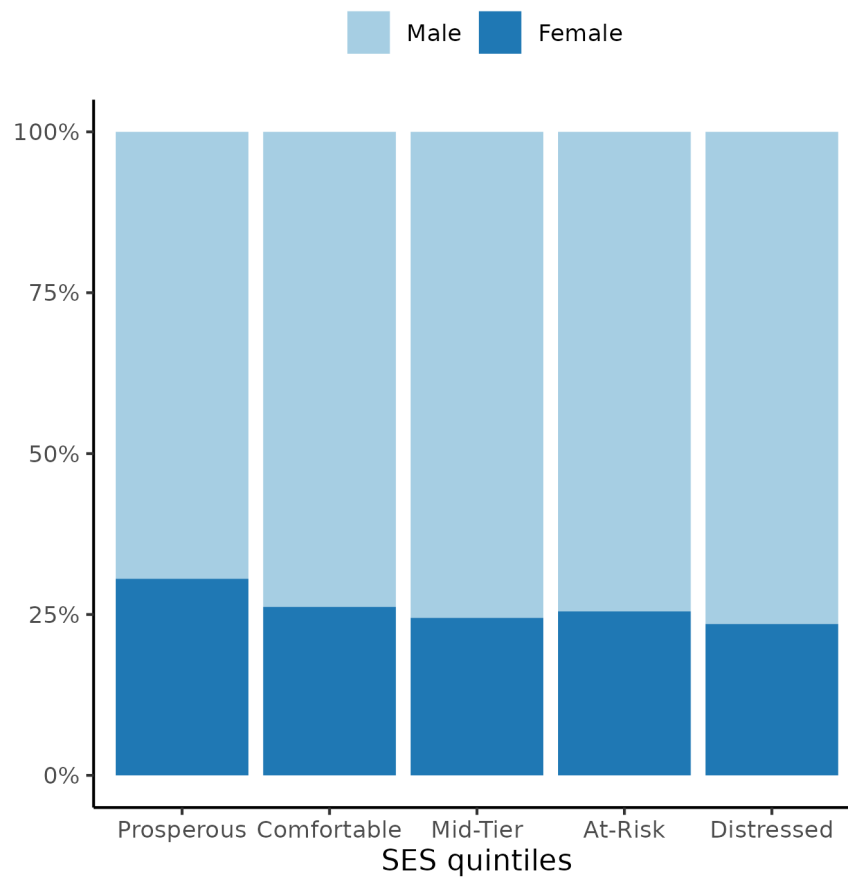


Figure A2 Distribution of SES in the study population.

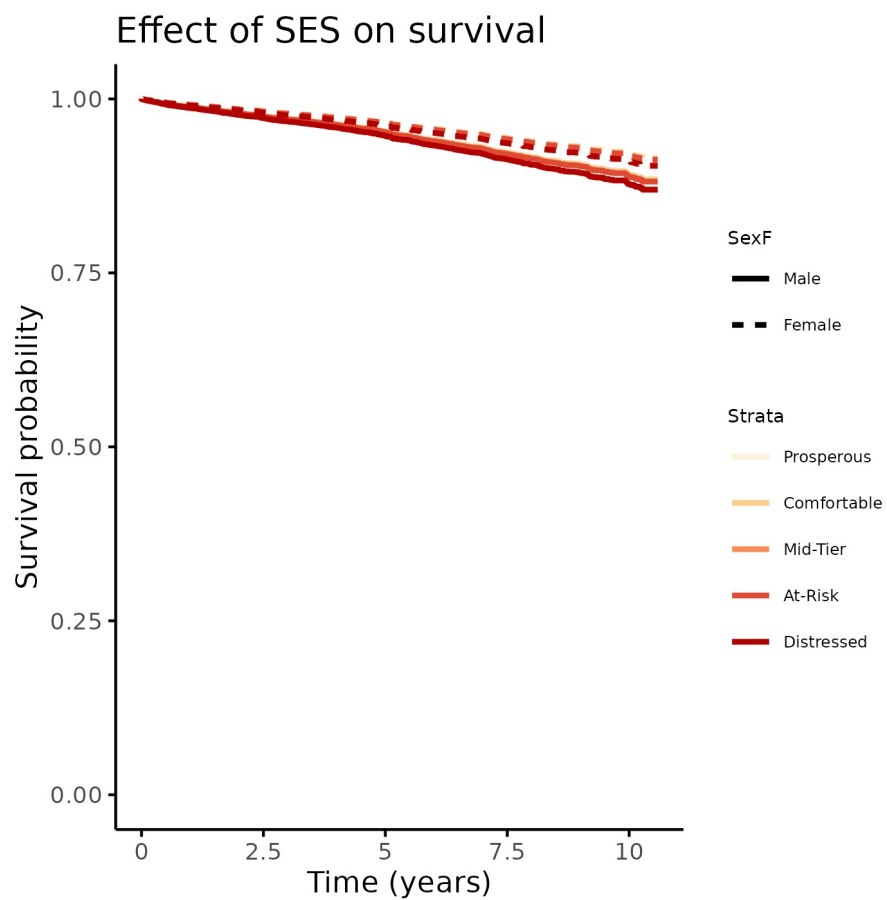


Figure A3 Alternative version of figure 2.

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8.2 Modeling strategy

Table A1 Alternative version of Table 2, showing effects from all covariates included in the model.

Characteristic	Crude estimate			Adjusted estimate			Late deaths		
	HR [†]	95% CI [†]	p-value	HR [†]	95% CI [†]	p-value	HR [†]	95% CI [†]	p-value
SES quintiles									
Prosperous	—	—		—	—		—	—	
Comfortable	1.28	1.04 to 1.57	0.020	0.99	0.80 to 1.22	0.898	1.00	0.78 to 1.29	0.973
Mid-Tier	1.08	0.86 to 1.34	0.514	1.12	0.89 to 1.41	0.330	1.07	0.82 to 1.40	0.624
At-Risk	1.20	0.97 to 1.49	0.088	1.01	0.81 to 1.27	0.901	1.10	0.85 to 1.42	0.483
Distressed	1.26	1.02 to 1.55	0.029	1.12	0.89 to 1.41	0.333	1.06	0.81 to 1.38	0.684
Sex:									
Male				—	—		—	—	
Female				0.72	0.62 to 0.85	<0.001	0.71	0.59 to 0.85	<0.001
What is your race?									
White				—	—		—	—	
Black				0.75	0.60 to 0.93	0.009	0.77	0.60 to 0.99	0.044
Hispanic				0.58	0.43 to 0.78	<0.001	0.62	0.44 to 0.88	0.006
Other				0.64	0.44 to 0.93	0.020	0.66	0.44 to 1.01	0.055
Age at injury				1.04	1.03 to 1.05	<0.001	1.04	1.04 to 1.05	<0.001
Substance Problem Use									
No				—	—		—	—	
Yes				1.44	1.23 to 1.69	<0.001	1.51	1.26 to 1.82	<0.001
Education									
Greater Than High School				—	—		—	—	
Less Than High School				1.26	1.03 to 1.55	0.026	1.32	1.04 to 1.67	0.021
High School/GED				1.45	1.24 to 1.70	<0.001	1.43	1.19 to 1.71	<0.001
At time of injury, what was your employment status?									
Employed				—	—		—	—	

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Unemployed				1.76	1.36 to 2.26	<0.001	1.74	1.30 to 2.32	<0.001
Other				1.81	1.50 to 2.19	<0.001	1.84	1.48 to 2.28	<0.001
Urbanization based on zip code of address at discharge.									
Suburban				—	—		—	—	
Rural				1.01	0.82 to 1.24	0.935	1.11	0.88 to 1.41	0.364
Urban				1.14	0.96 to 1.36	0.127	1.16	0.95 to 1.42	0.145
Spinal cord injury:									
No				—	—		—	—	
Yes				1.23	0.89 to 1.70	0.201	1.22	0.84 to 1.76	0.299
Cause of injury:									
Vehicular				—	—		—	—	
Violence				1.33	0.97 to 1.82	0.072	1.19	0.83 to 1.71	0.351
Falls				1.62	1.34 to 1.96	<0.001	1.48	1.19 to 1.83	<0.001
Other				0.98	0.73 to 1.32	0.900	0.99	0.71 to 1.37	0.930
Primary rehabilitation payor:									
Private Insurance				—	—		—	—	
Public Insurance				1.35	1.14 to 1.60	<0.001	1.50	1.22 to 1.83	<0.001
Other				1.12	0.80 to 1.56	0.512	1.26	0.87 to 1.82	0.221
Residence after rehab discharge:									
Private Residence				—	—		—	—	
Other				1.14	0.97 to 1.34	0.121	1.02	0.83 to 1.24	0.861
Days From Injury to Rehab Discharge				1.00	1.00 to 1.00	0.828	1.00	1.00 to 1.00	0.954
FIM Motor at Discharge:				0.98	0.98 to 0.99	<0.001	0.99	0.98 to 0.99	<0.001
FIM Cognitive at Discharge:				0.98	0.97 to 0.99	<0.001	0.99	0.98 to 1.00	0.147
*HR = Hazard Ratio, CI = Confidence Interval									

8.3 Availability

All documents from this consultation were included in the consultant's Portfolio.

The portfolio is available at:

<https://philsf-biostat.github.io/SAR-2023-004-BH/>

8.4 Analytical dataset

Table A2 shows the structure of the analytical dataset.

Table A2 Analytical dataset structure

id	exposu re	outco me	Tim e	Sex F	Rac e	Ma r	AG E	PROBLEMU se	EDUCATI ON	EMPLOYME NT	RURAL dc	PriorSe iz	SC I	Caus e	RehabPa y1	ResD is	DAYStoREHA Bdc	FIMMO TD	FIMCO GD
1																			
2																			
3																			
...																			
N																			

Due to confidentiality the data-set used in this analysis cannot be shared online in the public version of this report.